

## ATTACHMENT VII – NISS DESCRIPTION AND INSTRUCTIONS

# INSTRUCTIONS FOR THE NEUROMOTOR IMPAIRMENT SEVERITY SCALE (NISS)

### INTRODUCTION:

The Neuromotor Impairment Severity Scale (NISS) is an evaluation tool for that provides a quantified measurement of severity for children over one year of age with upper motor neuron disorders such as cerebral palsy, traumatic brain injury, and hypoxic-ischemic encephalopathy.

Based on World Health Organization definitions, an upper motor neuron disorder can be described in the following way:

Pathology	Impairment	Disability / Ability	Handicap / Participation
The underlying disease or disorder	The immediate physical consequences (physical findings)	Functional consequences (ability or disability to perform usual daily tasks)	Social and societal barriers to full participation in life activities

The **pathology** would be an abnormality found on MRI scan, CT scan, PET scan, and/or pathology report. **Impairment** would be an abnormality of motor control, posture, persistent primitive reflexes, balance, involuntary movement, tone and/or muscle contracture. **Disability** would be difficulty with self care and/or mobility. **Handicap** would be a community barrier (such as stairs) or a lack of participation in social and physical activity (often due to competitive disadvantage or social stigma).

Note that ability is a more appropriate term than disability. Similarly, participation is a more positive way to look at the concept of handicap. However, impairment does not have a positive counterpart. Despite the negative aspect of impairment, it is important to acknowledge the problem and to have a definable assessment of severity.

Classification of cerebral palsy based on the specific neuromotor abnormality (spasticity, dyskinesia, ataxia, rigidity, atonia) and the affected extremities (hemi, quad, etc.) does not describe adequately the severity of the neuromotor impairment.

There are a variety of tools to measure pathology, disability/ability, and handicap/participation. There are few tools to measure neuromotor impairment. Those that exist consider a single element of the impairment, such as the Ashworth Scale. The Neuromotor Impairment Severity Scale (NISS) is a method which evaluates three critical elements of the impairment (motor control, upright postural responses, and tone abnormality) in a quantitative fashion. The NISS total score ranges from 0-12 in increasing severity.

Individuals with upper motor neuron disorders often have associated cognitive and/or behavioral impairment. These problems can be mild or severe. The ability of the child to perform self care and mobility may be greatly affected by these additional factors. Since these problems are not motor in nature they need to be considered as significant co-morbidities.

<b>Impact of Co-Morbidities Seen in Upper Motor Neuron Disorders</b>	
Neuromotor Impairment	Alters the physical manner in which a task can be approached
Cognitive Impairment	Changes the understanding of the task
Behavioral Impairment	Affects the interest or motivation to perform the task

The NISS measures only the neuromotor component of the child's overall impairment. In order to obtain a full measurement of the problems facing a child with UMN, each of the co-morbidities must be assessed with an appropriate tool. Note that for an individual child and a given task, any one of the three impairments can be the most important.

## **GENERAL INSTRUCTIONS:**

The child should be examined in a quiet room with minimal distractions. The sequence of the evaluation may be altered to fit the needs of the child. If the child has difficulty cooperating, the examination can be repeated on a different day or time in order to obtain the best results. The evaluation should be completed within one month.

The examiner should have the assistance of another person to maintain and monitor the child's body alignment and cooperation.

The NISS evaluation tool is focused on three elements of the neuromotor problem: motor control, upright postural response, and tone abnormality. While other impairments may exist and may be recorded as comments, they are not scored.

Materials: a chair of appropriate size with back support (or wheelchair), a table top at appropriate height, small round ½ inch pieces of cereal, an ice cube tray, chocolate syrup, jelly, a mat table, a metronome (battery operated), a tennis ball on a string, a large brightly colored therapy ball, and a bright flashlight.

Please watch the videotape of NISS responses and scoring after reading the instructions and before using the NISS evaluation tool for the first time. Accuracy and reliability of scores depends on your thorough knowledge of the individual tests and how various children perform.

## **FRONT PAGE OF DATA SHEET:**

Fill in the demographic and diagnostic information on the top half of the page. The clinical findings are those that are known or suspected by the physicians or therapists. Mark all boxes that apply and write in "other" information. This information provides a context for the NISS evaluation tool.

The Neuromotor Impairment Severity Score Data Box is completed after the individual sections on the following pages are assessed.

## **I. MOTOR CONTROL**

Motor Control of the Head and Oral Structures:

**POSITION:** The child is placed in a chair with adequate trunk support and feet flat on the floor, if possible. A wheelchair with head rest and foot rests may be used. AFO's and a spinal brace may be used.

**HEAD ROTATION:** The child is asked or induced to rotate the head 45 degrees to each side. Verbal, visual, and tactile cues may be used. Do not use the root reflex.

**ABSENT:** The child does not respond to examiner by rotating 45 degrees in either direction. Head rotation is also considered absent if the movement is random or caused by tone.

**UNILATERAL RESPONSE:** The child responds to the examiner by rotating the head 45 degrees in one direction only.

**BILATERAL RESPONSE:** The child responds to the examiner by rotating the head 45 degrees in **each** direction.

**NECK FLEXION / EXTENSION:** The child is asked or induced to flex the neck, tilting the head forward and then back (extension) to the neutral position without going into hyperextension. Verbal, visual, and tactile cues may be used.

**ABSENT:** The child is unable to respond to the examiner with 30 degrees of head flexion and return to neutral. Head flexion and extension is considered absent if the movement is caused by gravity or tone, or if the head always extends beyond neutral into extension.

**PARTIAL RESPONSE:** The child tilts the head forward 30 degrees and then part way back to neutral.

**COMPLETE RESPONSE:** The child tilts the head forward 30 degrees and then back to neutral without going into hyperextension.

**LIP PUCKER / KISS:** The child is asked or induced to purse the lips AND make a kissing noise with the lips. Verbal, visual, and tactile cues may be used.

**ABSENT:** The child is unable to purse the lips AND unable make a kissing noise with the lips.

**PARTIAL RESPONSE:** The child purses the lips but cannot make an audible noise with the lips OR the child does not purse the lips but makes a distinct kissing sound using both lips. A substitute noise does not count. Watch and listen carefully. Some children use their tongue against the palate or the lower lip against the teeth, etc.

**COMPLETE RESPONSE:** The child purses the lips AND makes a distinct kissing sound using both lips. A substitute noise does not count. Watch and listen carefully. Some children use their tongue against the palate or the lower lip against the teeth, etc.

**TONGUE LATERALIZATION:** The child is asked or induced to lateralize the tongue right and left. Verbal, visual, and tactile cues may be used. A spot of food, such as jelly or chocolate syrup, may be placed on the outside corner of the mouth. The response can be expected within seconds of placing the stimulus at the side of the mouth.

**ABSENT:** The child does not bring the tongue to the lateral border of an open mouth on either side.

**PARTIAL RESPONSE:** The child moves the lateral edge of the tongue out of the mouth laterally, on **one** side only, far enough to reach the corners of a open mouth.

**BILATERAL RESPONSE:** The child moves the lateral edge of the tongue out of the mouth laterally, both **right** and **left**, far enough to reach the corners of an open mouth.

**Motor Control of the Upper Extremities:**

**POSITION:** The child is placed in a chair with adequate trunk support and feet flat on the floor or wheelchair footrest if a wheelchair is used. A bench may be used if the child has adequate trunk balance. AFO's and a spinal brace may be used, but no orthotics or splints may be worn on the upper extremities. A table or tray is placed in front of the child at a level between the lower sternum and the umbilicus. The amount of motor control that the child can use is being evaluated. Children with normal isolation of movement in the hand can **also** reach and grab objects in a synergistic fashion, particularly when the action is performed quickly. The examiner needs to observe a number of efforts to identify the child's best motor control. The following options may be necessary:

- Demonstrate the grasp for the child
- Ask or induce the child to pick up the cereal more slowly.
- Ask or induce the child to get the piece of cereal out of an ice cube tray or medicine cup.
- Ask or induce the child to pick up a smaller piece of the cereal.
- Ask or induce the child to take the piece of cereal from the examiner's pincer grasp.

**PROCEDURE:** A piece of cereal (doughnut shaped and approximately ½ inch in size) is placed 4 inches in front of the hand to be tested. (Midline placement is not necessary.) The child is asked or induced to pick up the piece of cereal. Verbal, visual, tactile cues may be used. If necessary the other hand may be restrained.

**CAUTION:** Do not let the child place the cereal in his/her mouth if swallowing problems are suspected or unknown.

**RESPONSE AND SCORE:** (Circle the score that best fits the child's response.)

0 = There is completely normal movement. The extension/flexion (E/F) of digits 1 and 2 is not associated with E/F of digits 4 and 5. In other words the radial side digits operate independently from the ulnar side digits. Normal hand posture, speed and agility must be present. In addition, assessment of strength must be performed: grip strength of first 2 digits, and whole hand grip strength. Any method of testing hand and finger strength may be utilized. When any pathologic problem such as spasticity, dyskinesia, ataxia, hypotonia, OR the need to lean the same arm on the table for stability is present in the hand or arm, the extremity cannot be scored as normal.

1 = There is isolated movement of the fingers as above, but there is abnormal strength, hand posture, speed, or agility. Circle the abnormality on the score sheet

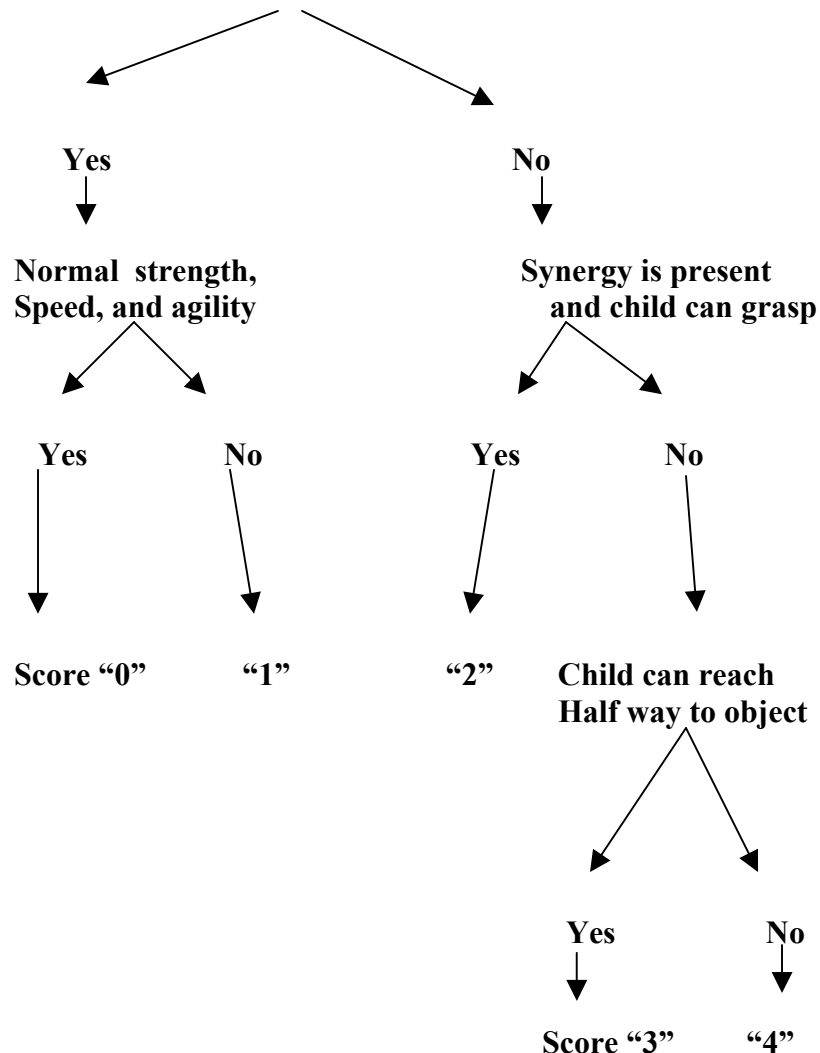
2 = There is a synergistic grasp on all efforts. (E/F of the first two digits is always associated with E/F of digits 3-4-5.

3 = No grasp is seen but the arm approaches the object (moves at least 50% of the 4 inches distance to the object).

4 = The arm does not move significantly (moves less than 50% of the 4 inches distance to the object). The problem can be due to lack of ability, vision, or awareness. (A score of 4 may be given if the caretaker states that the arm never moves voluntarily.)

When analyzing the motor control of the upper extremity this algorithm is recommended:

**Movement of digits 1-2 is isolated from 3-4-5**



Remember, to declare an upper extremity normal ("0"), strength must be tested.

**Motor Control of the Lower Extremities:**

**POSITION:** The child is placed in a chair with adequate trunk support and feet hanging freely with shoes and socks removed. The back should be well supported so that the hips and other leg are not activated by balance reactions. Hips and knees should be as close to 90 degrees of flexion as possible. The trunk must be as straight as possible. The child's usual wheelchair may be used with foot rests removed. Set the wheel chair as upright as possible. The child's head may be supported if necessary. AFO's may not be used. The format and concepts are similar to the upper extremity motor control. Slow, gently movement is more likely to demonstrate isolation of muscle function. A forceful kick will recruit all leg muscles in a synergistic fashion.

**PROCEDURE:** The child is asked or induced to touch or gently kick a tennis ball (which is suspended by a string) 4 inches in front of the foot at the level of the ankle maleoli. Verbal,

visual, tactile cues may be used. If the child is unable to see the tennis ball or cannot visually track the movement of the ball, a larger ball may be used (such as a red therapy ball placed on the floor in front of the foot). The examiner watches for knee extension but also observes pelvic motion (posterior tilt) and movement of the other leg. A hand may be placed on the sacrum to better detect motion. Be sure that the child has good back support so that the opposite leg does not need to extend for balance during the kick. Note that synergistic knee-hip extension will occur simultaneously, whereas short hamstrings can cause the pelvis to tilt posteriorly **after** the knee extension has already begun.

**RESPONSE AND SCORE:** (Circle the score that best fits the child's response. These are the Extremity Motor Control Sub-Scores which are taken to the front page.)

0 = Knee extension is normal. The movement can be performed without hip extension or significant movement in the other leg when the ball is kicked gently. The kick must be precise (directed straight at the ball). The examiner **then** checks knee extension strength and speed of movement. All must be normal. When any pathologic problem such as spasticity, dyskinesia, ataxia, or hypotonia is present in the leg the extremity cannot be scored as normal.

1 = Knee extension is isolated from pelvic and other leg movement but is lacking in precision, strength or speed. Circle the abnormality on the score sheet. There may be an "associated movement" of the other leg but the hip should not show extension synergy.

2 = Knee extension is synergistic with hip extension on each effort, but the other leg is not significantly involved. (There may be slight or occasional movement of the other leg.)

3 = Knee extension is synergistic with hip extension **and** there is simultaneous and symmetrical extension of the contra-lateral knee on each effort.

4 = Voluntary knee extension is insufficient to reach to the ball **OR** a **stepping** action is activated. (A score of 4 may be given if the caretaker states that the legs never move voluntarily.)

**NOTE: A stepping action (while seated) does not qualify as a kick or knee extension.**

## **II. UPRIGHT POSTURAL RESPONSES**

**POSITION:** The child is seated on a mat table (not a ball) with legs dangling. The examiner provides support of the trunk as noted below.

**HEAD RIGHTING RESPONSE:** With the examiner's hands on the upper trunk, the child is tilted laterally and slowly 30 degrees in each direction. Visual and verbal cues are allowed.

**ABSENT:** The child does not return the head to the vertical position.

**INCOMPLETE OR UNILATERAL RESPONSE:** The head returns part way to the vertical position on both sides or all the way on one side only.

**NORMAL RESPONSE:** The head returns to the full vertical position from **both** sides. Full vertical position refers to AP and lateral planes. Note that the eyes should return to a horizontal position.

**TRUNK RIGHTING RESPONSE:** If the child has adequate head responses, the examiner slides the hands down to the pelvis and tilts the pelvis slowly in the lateral direction approximately 30 degrees.

**ABSENT:** The child's head lags toward the ground or does not change position relative to the trunk. A score of "absent" can be given without testing if the child has an "absent" for the head righting response.

**INCOMPLETE OR UNILATERAL RESPONSE:** The head and trunk return part way to the vertical position on both sides or all the way on one side only.

**NORMAL RESPONSE:** The head and trunk returns to the full vertical position from **both** sides. Full vertical position refers to AP and lateral planes. Note that the orbits should return to a

horizontal position. The child may bring the head past vertical toward the other side in order to maintain balance.

PROTECTIVE EXTENSION: If the child has adequate trunk responses, the examiner pushes the mid-trunk toward the side. Lateral protection is tested on each side

ABSENT: The child does not abduct OR extend the arm. A score of “absent” can be given without testing if the child has an “absent” for the trunk righting response.

INCOMPLETE RESPONSE: The arm abducts partially OR extends partially toward the fall but is inadequate to prevent the fall to the mat.

NORMAL RESPONSE: The arm extends and successfully prevents the fall to the mat. The hand and elbow do not have to be fully extended, but the child must be able to prevent the head from hitting the mat.

### III. TONE ABNORMALITY

#### Axial Tone

HEAD LAG TEST:

POSITION: Supine.

PROCEDURE: The examiner pulls the child by the arms toward the sitting position (three trials). Note that the amount of the head lag is the determinant for the child’s score. This reflects the **neck flexor tone**. The amount of head movement toward flexion after the lag has occurred is a measure of **neck flexor strength** and is not the factor that is being tested here. The assistant should observe from the side.

NORMAL RESPONSE: There is **minimal lag** of the head as the child is pulled to sit.

PARTIAL HEAD LAG: The head **lags significantly**, but not into full extension, as the child is pulled to sit.

COMPLETE HEAD LAG: The head **lags into full extension** as the child is pulled to sit.

AXILLARY LIFT TEST:

POSITION: The child is seated on a bench, in the examiner’s lap or in the child’s usual wheelchair with seatbelt unbuckled (three trials).

PROCEDURE: The examiner wiggles the arms to determine whether the tone of the shoulder depressors and adductors is low, normal, or high. Then the examiner lifts the child under the axillae without placing pressure on the thorax, using stiff, straight hands and fingers. The child’s shoulders and ears must be easily visible. If head control is poor an assistant may hold the head steady. Select the best of three responses and score as follows:

NORMAL RESPONSE: The shoulder girdle reacts with downward pressure during the lift, keeping the shoulders at neutral or less than half way elevated to the ears. Initial tone can be normal or low. Be sure that the buttocks are lifted off the mat during the lift.

PARTIALLY ABNORMAL RESPONSE: The shoulder girdle reacts with downward pressure and resists slide through but the shoulder girdle is elevated and stays elevated (shoulders move half way or more to the ears). Initial tone can be either normal, low, or high).

COMPLETELY ABNORMAL RESPONSE WITH **LOW RESTING TONE**: The child slides completely through during the lift.

COMPLETELY ABNORMAL RESPONSE WITH **HIGH RESTING TONE**: The child can be lifted out of the chair and the shoulders do not elevate significantly (move less than half way to the ears).

#### Extremity Tone Abnormality:

POSITION: Upper extremity tone is examined in a comfortable seated or supine position. The lower extremity is examined in the supine position. **The head must be maintained in neutral position.** An assistant is necessary to maintain the head in neutral, monitor the posture, and keep the child relaxed.

- Shoulder adduction is tested in the lateral plane. All shoulder muscles are tested together and the scapula is not restrained. SEE DIAGRAM ONE
- Elbow F/Es are tested with the shoulder slightly abducted. SEE DIAGRAM TWO
- Wrist F/Es are tested with the elbow at 90 degrees and with the forearm in neutral supination/pronation if possible. The fingers should remain flexed during the stretch. SEE DIAGRAM THREE
- Finger F/Es are tested with the wrist at zero degrees of extension and the forearm at neutral supination/pronation if possible. SEE DIAGRAM FOUR
- Hip adduction is tested with the hips and knees at 90 degrees. SEE DIAGRAM FIVE
- Hip F/Es are tested with the sacrum flat on the mat. SEE DIAGRAM SIX
- Knee F/Es are tested with the hip at 90 degrees of flexion. SEE DIAGRAM SEVEN
- PF/DFs are tested with hip and knee at 45 degrees of flexion. The subtalar joint should be stabilized or locked during the stretch. SEE DIAGRAM EIGHT

The tone scale is designed to assess hypotonia, indicated with an “L” after the number, and all forms of hypertonia (spasticity, dystonia and rigidity), indicated with an “H” after the number. A “4 C” (for contracture) is used if the range of motion is less than 25% of normal **OR** for a joint such as the ankle that has been surgically fused or limited.

	NISS TONE SCALE
<b>4 L</b>	<b>Atonic (there is no opposition to gravity)</b>
<b>2 L</b>	<b>Low tone</b>
<b>0</b>	<b>Normal</b>
<b>1 H</b>	Fast stretch ( <b>one second stretch or less</b> ) meets a slight muscle catch or slight resistance, and best range of motion is easily achieved
<b>2 H</b>	Slow stretch ( <b>two seconds stretch</b> ) achieves the best range of motion
<b>3 H</b>	Very slow stretch ( <b>three seconds stretch</b> ) achieves the best range of motion
<b>4 H</b>	Extremely slow stretch ( <b>four seconds stretch or greater</b> ) achieves the best range of motion
<b>4 C</b>	Range of Motion is less than 25% of normal

**Selection of flexor or extensor muscles** is done in the following way. **Before testing** the amount of muscle resistance, observe the posture of the extremity. Test flexors when the joint is in flexion and test extensors when the joint is in extension. If the posture is neutral gently move the limb 10 to 30 degrees in each direction from its resting state. If the muscles are both hypotonic choose the most hypotonic. If the muscles are both hypertonic select the most hypertonic. If one is hypertonic and the opposite muscle group is hypotonic, score the hypertonic one. If unsure about the muscle group that should be tested, select the flexors. In the case of the ankle choose the plantar-flexors. Circle the tested muscle group on the score sheet.

A series of stretches at successively slower speeds is then provided. The most reliable way to pace the stretch is to use a metronome set to a speed of 60 to match a count of “GO, ONE, TWO,



THREE, FOUR.” Alternatively an assistant can provide the count. Self pacing is difficult because stretching at progressively slower paces tends to slow the counting pace.

The evaluation of tone is performed with sequentially slower stretches. For accuracy and reliability the stretches must be done exactly as described. Note that after doing a fast stretch one is tempted to do ONE very slow stretch and count the seconds to full range. That is not the method described below and will likely give spurious results.

**The first step** is to provide a fast stretch. Attempt to move through the entire normal range of motion in approximately **one second**. If the muscle is hypotonic, there are only two levels: low tone (2 L) and atonic (4 L). Atonic means NO tone (there is no opposition to gravity.) If full range of motion is obtained with the one second stretch then no further stretch of that muscle group is needed. The score is “0” if the resistance is normal and the score is “1 H” if there is abnormal resistance or a muscle catch. If the muscle group is hypertonic and full range of motion has been achieved, the fast stretch may be repeated to be sure there is a catch or abnormal resistance. However, from this point onward steps cannot be repeated.

**The second step** is to provide a slow stretch (**two second stretch**) to determine if better range of motion can be achieved. Turn on the metronome at this time and leave it on for the remaining steps. **Do this stretch one time** to avoid relaxing the muscle by the stretch itself. If the range achieved is better than the last step the score is “2 H” or higher. If the range is still not normal, the examiner continues.

**The third step** is to provide a very slow stretch (**three second stretch**). **Do this stretch one time** to avoid relaxing the muscle by the stretch itself. If the range achieved is better than the last step then the score is “3 H or higher.” If the range is still not normal, the examiner continues.

**The fourth step** is to provide an extremely slow stretch (**four second or greater stretch**). **Do this stretch one time** to avoid relaxing the muscle by the stretch itself. If the range achieved is better than the last step then the score is “4 H.” If the stretch takes longer than 4 seconds this can be written as a comment on the score sheet but the score is still recorded as “4 H.” Some children have very severe muscle, joint, and/or soft tissue contracture. The resistance within the available range may be anywhere from low to high with an extreme or sudden resistance at end range. Regardless of the muscle resistance, a “4 C” (referring to **contracture**) is to be used when the range of motion is less than 25 % of the normal.

At this point, repeating the procedure is not possible since the stretches already provided may have relaxed the muscles and a different score would result. If the test needs to be repeated this should be done on another day.

**When totaling the tone score for the extremity ignore the “L” and “H” designation and add all numbers.** A “2 L” is the same value as a “2 H” The “L,” “H,” and “C” is placed on the score sheet to indicate the reason for the numeric value.

## **CALCULATIONS:**

The calculations are described on the Neuromotor Impairment Data Sheet and are performed automatically by the NISS calculator.

## **CONCLUSION:**

Check that all computation is correct. Check that all scores are placed in the appropriate boxes on the front page. Add the Motor Control, Upright Postural Responses, and Tone Abnormality scores together to obtain the total NISS score. These are not averaged.

Check the “Clinical Findings” Section to mark additional boxes for any new findings discovered while performing the NISS